MUON CRYOSYSTEM DESIGN NOTE 17

SUBSYSTEM: [X] CCM [ ] CVM [ ] Cryoplant

TITLE: Sensitivity of the Imbalance Voltage Detection System

AUTHOR: R.I. Dachniwskyj RID

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Objective of Note

To determine how many feet of the superconducting cable needs to go normal at 10K to produce a voltage of 75 millivolts.

Calculations and Discussion

From the paper written by W. Craddock on April 2, 1985 titled "Summary of the Tohoku Magnet Stability, Burnout Protection, and General Electrical Integrity" shows (Fig. 2) that the measured RRR for the CCM conductor is 100. The area of the conductor minus the area of the 6 superconducting strands is 6.46×10^{-2} cm^2. The resistivity of RRR 100 copper at $10^{o}K$ as given by the Handbook on Materials for Superconducting Machinery, page 5.11.1 (11/76), is 1.57×10^{-8} ohms-cm. Resistance for the cable is $(1.57 \times 10^{-8})/(6.46 \times 10^{-2}) = 2.43 \times 10^{-7}$ ohms/cm. The peak magnet field in the coil package is 2.85 Tesla.

The minimum detectable length of normal conductor (x) is determined at 2.85 T as follows:

$$V = IR\ (1 + 0.31\ B)$$

$$0.075 = (875)(2.43 \times 10^{-7})(x)[1 + (0.31)(2.85)]$$

$$x = 187.3\ cm$$

The maximum normal length associated with 75 mV is determined at 0 T as follows:

$$V = IR$$

$$0.075 = (875)(2.43 \times 10^{-7})(x)$$

$$x = 352.7\ cm$$

The average length of the one turn in the CCM magnet is $\pi(206)(2.54) = 1644$ cm.

Conclusion

1. The maximum fraction of a turn that needs to go normal for the imbalance voltage circuit to see 0.075 volts is 352.7/1644 = 0.21.

2. The minimum fraction of a turn that needs to go normal for the imbalance voltage circuit to see 0.075 volts is 187.3/1644 = 0.11.

Reviewed By

R. Wood Apr 4, 1986